

# Effects of Ramadan Fasting on Inspiratory Muscle Function

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## Abstract

**Background:** Ramadan fasting is a major challenge for exercising Muslims especially in warm seasons. There is some evidence to indicate that Ramadan fasting causes higher subjective ratings of perceived exertion (RPE) in fasting Muslims. The mechanisms of this phenomenon are not known exactly. The role of respiratory muscle strength in this regard has not been studied yet.

**Objectives:** The aim of this study was investigation of the effects of Ramadan fasting on respiratory muscle strength.

**Patients and Methods:** In a before-after study, from 35 fasting, apparently healthy, male adults who had fasted from the beginning of Ramadan, maximal inspiratory muscle pressure (MIP) and peak inspiratory flow (PIF) were measured in the last week of Ramadan month in summer. At the time of test, there was not any sleep problem in participants and all of them had good cooperation. Three months later, after exclusion of incompatible persons mainly because of change in their physical activity level, smoking behavior or drug consumption, the measurements were repeated in 12 individuals.

**Results:** Weight, MIP and PIF data had normal distribution (Kolmogorov-Smirnov Test). There was a significant increase in MIP (mean 8.3 cm H<sub>2</sub>O with 95% confidence interval of 2.2 - 14.3) and PIF (mean 0.55 lit/s with 95% confidence interval of 0.02 - 1.07) and weight (mean 3.4 Kg with 95% confidence interval of 2.2 - 4.5) after Ramadan (Paired t test with P < 0.05). When weight difference was used as a covariate in repeated measure ANOVA test, there was no further significant difference between MIP and PIF measurements.

**Conclusions:** Ramadan fasting may cause reduction of respiratory muscle strength through reduction of body weight.

**Keywords:** Fasting, Respiratory Muscle, Athletes

## 1. Background

Ramadan fasting is a mandatory religious act for Muslims. It requires a total abstinence from food, drink and some other pleasures including sexual activity from sunrise to sunset for a period of one lunar month yearly. Time of fasting is about 12 to 17 hours in different geographical areas and seasons. Thus, in Ramadan fasting, in addition to abstinence from food and drink, time of eating, drinking, and sleeping will change and this may affect athletic performance.

In Ramadan, most sport competitions in Islamic countries take place after sunset (1). Historically, some important and international athletic events were held in Ramadan month (for example, 2012 Summer Olympic games in London, England and FIFA world cup 2014 in Brazil) (2). In these situations when the events occur in daylight hours, Ramadan observance can be a major challenge for exercising Muslims especially in warm seasons.

Although, there is limited knowledge about physiological changes which occur when a fasting Muslim does exercise, there is some evidence which indicate Ramadan ob-

servance can have negative effects on subjective ratings of perceived exertion (RPE). In other words, during exercising in the Ramadan fasting state, RPE scores are higher in comparison to the same exercise done in the non-fasting state (3-6). There are some explanations for this, such as being in hypohydrated, hunger state, change of sleep patterns and fatigue especially when exercise is done in late afternoon (7). It is important to note in addition to time of the day, the total fasting days may influence the RPE. In this regard, the role of respiratory muscle function in fasted state has not been studied yet.

On the other hand, there is some evidence which indicates the results of exercise performance tests such as agility, power and balance tests are not affected by Ramadan fasting state (8, 9). In a recent systematic review and meta-analysis, it has been concluded that respiratory muscle training improves endurance exercise performance in healthy individuals with greater improvements in less fit individuals (10). As we know that inspiratory muscle fatigue can occur during exercise (11), It may be a contributing factor for higher RPE in fasting state. Because

of consumption of larger meals at night and in the early morning, intermittent Ramadan fasting has only trivial effects upon the overall nutrition of the sedentary people (12). Nevertheless, the effect of change of nutrition on respiratory muscle strength in Ramadan fasted healthy persons has been yet unknown.

## 2. Objectives

As we do not know the effect of fasting on respiratory muscle function tests, the aim of this research was studying the effects of Ramadan fasting on inspiratory muscle function. Knowledge of this type can guide the practitioner to devise strategies for lessening the impact of Ramadan fasting on the exercising individual.

## 3. Patients and Methods

After local announcement, in a before-after study, from 35 fasting male adults weight, height, maximal inspiratory muscle pressure (MIP) and peak inspiratory flow (PIF) were measured in the last week of 2014 Ramadan month in summer. The inclusion criteria were apparently healthy male persons without age restriction, negative smoking, or drug history, Ramadan observance from beginning of Ramadan until the time of the test, absence of sleepiness during the test, and having good cooperation. The measurements were done by an experienced technician using POWER breathe inspiratory muscle trainer (KH1 pressure threshold device). After proper device calibration and instruction to participants according to the manual of the device and getting their consent, MIP and PIF were measured by having the subject expire completely and then perform a maximum inspiratory maneuver through mouth while the nostrils were closed (Mueller maneuver). Three measurements were done and the best score was recorded. Also the persons were asked about their physical activity level in Ramadan month and it was recorded as weekly volume (time, intensity as RPE and type) of physical activity. Three months later, after exclusion of incompatible persons (23 people), the measurements were repeated in the rest of the subjects (12 persons). The incompatible individuals for second measurement were recognized as those who after Ramadan changed their physical activity level, smoked, consumed drugs and had inappropriate cooperation (including sleepiness). Both measurements were done at about the same time at noon (about 8 hours fasting). The data were analyzed by SPSS 16 software and relevant statistical tests.  $P < 0.05$  are considered significant.

## 4. Results

The descriptive statistics of participants in post Ramadan measurement are summarized in Table 1. Weight, MIP and PIF data had normal distribution (Kolmogorov-Smirnov Test). There was a significant increase in MIP (mean 8.3 cm H<sub>2</sub>O with 95% confidence interval of 2.2 - 14.3,  $P = 0.011$ ) and PIF (mean 0.55 lit/s with 95% confidence interval of 0.02 - 1.07,  $P = 0.04$ ) and weight (mean 3.4 Kg with 95% confidence interval of 2.2 - 4.5,  $P < 0.001$ ) after Ramadan (Paired t test). When weight difference was used as a covariate in repeated measure ANOVA test, there was no further significant difference between Ramadan and post Ramadan measurements of MIP and PIF ( $P = 0.85$ ).

## 5. Discussion

According to our results, 3 months after Ramadan fasting, respiratory muscle function reflected by MIP and PIF was better than in Ramadan month and this effect was not seen when weight difference of persons was regarded as a covariate.

Maximal inspiratory pressure (MIP) is a reliable, noninvasive factor for assessing the respiratory muscle function (13). Recently peak inspiratory flow (PIF) measurement has been of interest as a reliable and accessible tool for assessment of respiratory muscle strength in older adults (14). Maximal inspiratory pressure (MIP) is the most commonly used measure for assessment of inspiratory muscle function (15). Subjective factors which may influence MIP include proper test performance, weight, age, sex, height, fitness level and smoking status (15, 16). There is no agreement regarding which of these variables have a significant influence on MIP (15). Although studies on the effects of Ramadan fasting on weight change have had conflicting results, in a recent systematic review, it was concluded that fasting during Ramadan could result in relatively small but significant weight loss in both genders and most of the weight lost was regained within a few weeks after Ramadan (17). So as in our study, at the time of second measurement the relatively small but significant increase in weight of participants may be the reason of significant increase of respiratory muscle function test results. Although weight gain can have positive effect on MIP (16), it is important to note the amount of weight change which is necessary to influence MIP has not been agreed on yet (15).

There is some evidence which indicates if sleep problems do not exist, and training stimulus is maintained, anaerobic power and capacity will remain unchanged in fasting state (18-20). Also it seems that muscle contractile force and strength will not change considerably in fasting state if subjects maintain their hydration, motivation

**Table 1.** Descriptive Statistics of participants in Post Ramadan Measurement

Descriptive Statistics	Minimum	Maximum	Mean $\pm$ SD
Age, y	22.00	64.00	43.1667 $\pm$ 11.73
Height, cm	160.00	186.00	172.45 $\pm$ 7.96
Weight in Ramadan, Kg	54.00	91.00	77.33 $\pm$ 10.55
Weight after Ramadan, Kg	58.00	95.00	80.75 $\pm$ 10.93
MIP in Ramadan, cm H <sub>2</sub> O	51.00	123.00	84.5000 $\pm$ 20.83048
MIP after Ramadan, cm H <sub>2</sub> O	74.00	133.00	92.8333 $\pm$ 18.00926
PIF in Ramadan, lit/s	2.00	6.10	4.0833 $\pm$ 1.26191
PIF after Ramadan, lit/s	2.40	6.40	4.6333 $\pm$ 1.15863

and training status (21-23). In our study, measurement of the MIT and PIF indeed were an anaerobic power task as the person recruited his respiratory muscles maximally in a few seconds (24). We emphasized that our participants would not be in a sleepy state and have good cooperation. Also we excluded persons who changed their physical activity level after Ramadan. Thus, change of the weight of individuals probably caused the observed results. As our participants were for at least 8 hours in fasted state and had observed Ramadan fasting for about 3 weeks in summer, there was probability that dehydration might take part in weight change of the participants, though we do not know the exact role of dehydration or other changes in body composition in the observed results.

Relationship between nutritional status and MIP has been studied in some diseases. In some studies, in cystic fibrosis and chronic obstructive pulmonary disease (COPD) patients, inspiratory muscle function, and MIP had no significant relationship to nutritional status or support (25, 26). Recently in a systematic review, the effect of improving nutrition on increase of MIT and weight has been observed in individuals with chronic obstructive pulmonary disease (COPD) who had low body weight (malnourished) (27). In our study, the weight difference has been used as an index of changing dietary status in participants (as the height of the persons was constant, it can be used instead of body mass index).

Our study has some limitations. First, due to relatively large time gap (3 months) between the first and second measurements which was necessary to bring the fasting induced changes into before Ramadan state, second, measurement took place in a small number of persons (some lifestyle changes and in cooperation of participants made them inappropriate for second measurement). Therefore, the results may change if the study takes place over larger number of participants. In addition, although we used weight difference as an index for changing nutritional sta-

tus of participants, we could not perform a complete body composition analysis of persons (due to lack of appropriate instruments) for proper discrimination of the effect of each part of body (water, fat free mass, fat) on respiratory muscle strength. Finally, as our cases were not elite athletes, extension of finding to this group cannot be made.

### 5.1. Conclusion

Ramadan fasting may cause reduction of respiratory muscle strength through reduction of body weight. Further studies with larger sample sizes and control of all confounding factors are needed to know the effect of fasting on respiratory muscle strength.

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### Footnotes

**Authors' Contribution:** Mohsen Soori and Shahram Mo-haghegh developed the original idea and the protocol, abstracted and analyzed data, wrote the manuscript; Maryam Hajian and Behrooz Moraadi contributed to the development of the protocol, abstracted data, and prepared the manuscript.

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